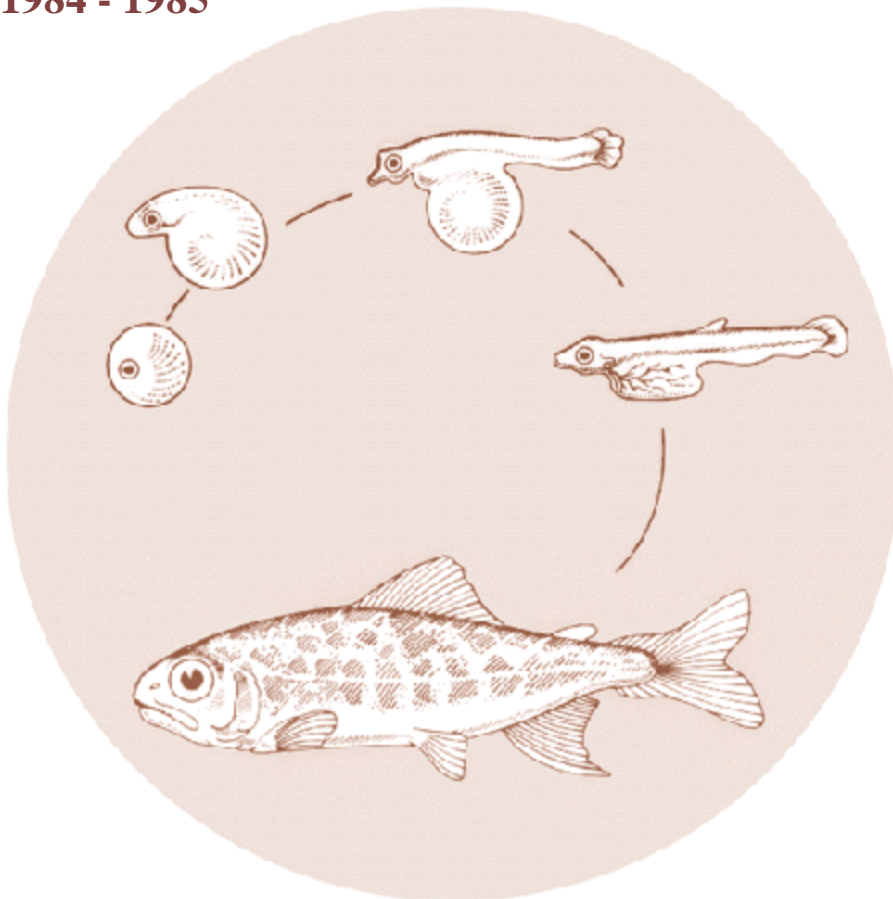


Protection of Wild Adult Steelhead in Idaho by Adipose Fin Removal

**Annual Report
1984 - 1985**



DOE/BP-14903-1

March 1986

This Document should be cited as follows:

*Duke, Rodney, "Protection of Wild Adult Steelhead in Idaho by Adipose Fin Removal",
Project No. 1984-00200, 41 electronic pages, (BPA Report DOE/BP-14903-1)*

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This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

PROTECTION OF WILD ADULT STEELHEAD IN IDAHO
BY ADIPOSE FIN REMOVAL

Annual Report

by

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P.O. Box 3621
Portland, Oregon 97208
Projects 84-2
Contract No. DE-A-179-84BP14903

March 1986

INTRODUCTION

The improved survival of hatchery-reared steelhead in recent years has created serious stock management problems. Hatchery-reared steelhead present harvestable surpluses, while wild stocks remain at low levels. Angling pressure directed on hatchery stocks could overharvest wild stocks. To differentially harvest hatchery and wild stocks in a sport fishery, various external identifiers have been used. Because hatchery fish are usually raised in concrete raceways under more crowded conditions than their wild counterparts, the presence or appearance of various fins have been used to distinguish between hatchery and wild fish. The presence of fins with reduced size or deformation usually indicates hatchery fish. In Idaho, several regulations regarding dorsal fin height have been used to separate wild and hatchery fish. However, these regulations apply to a small geographical area and have not proven successful in fisheries statewide. In an attempt to find a better external mark, fishery scientists have utilized an adipose fin clip to identify hatchery fish. This mark can be applied easily to hatchery fish prior to their release, is permanent if done correctly, and is easily recognizable by anglers. It is also considered to be essentially harmless since the adipose is believed to be without physiological purpose.

The objectives of this project were to:

1. Remove the adipose fins from all Idaho hatchery steelhead.
2. Review current information on the use of adipose clipping.
3. Determine the physiological role of the adipose fin if possible.

METHODS

All steelhead reared in Idaho hatcheries for release in the spring of 1985 were marked with an adipose clip. The marking operations were conducted in mobile marking facilities specially designed to efficiently handle the large number of fish and reduce marking stress (Duke 1985).

Fifty fish samples were randomly taken throughout the clipping operation to determine the quality of the clip. Fin clips were evaluated into five categories: excellent (100% removal); too deep (100% removal, but with secondary infections or complications possible); poor (less than 10% remaining at the leading edge); partial (10-25% remaining); and not clipped (more than 25% remaining) (Fig. 1). All clip categories except "not clipped" are felt to be good enough to be used to identify returning adult fishes.

Fish health was monitored throughout the rearing cycle and any mortalities were noted. Final mortality attributable to marking was

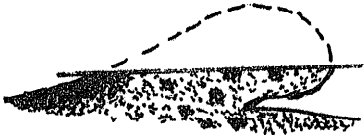







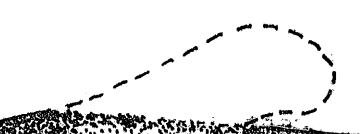

Type of Clip	VARIATION	
	Minimum	Maximum
Unclipped 25% remaining		
Partial 10-25% remaining		
Poor 10% remaining		
Too Deep 100% removal		
Excellent 100% removal		

Figure 1. Adipose clip quality rating system for Idaho steelhead hatcheries; based on visual inspection.

calculated by subtracting the daily mortality before marking began from the mortality level after marking until the mortality rate stabilized at daily pre-marking levels. In some cases, rearing histories from the previous year were used to estimate the normal daily mortality rate for that particular stage of rearing.

In vivo experiments on healing rate were conducted at Dworshak National Fish Hatchery. Both unclipped (control) and clipped (test) fish were held. In addition, different types of clips representative of the five categories of clip quality were held to test differences in healing and to see if rejuvenation occurred. Idaho Department of Fish and Game (IDFG) personnel monitored the tests and documented the healing process photographically at set intervals. Additional tests were started at Niagara Springs Fish Hatchery but had to be discontinued because of holding problems.

Samples of juvenile and adult adipose fins were sent to the U.S. Fish and Wildlife Service Fish Cultural Development Center. Charlie E. Smith, Director, examined histological sections for tissue composition,

I did extensive reviews of literature on hooking mortality rates, present use of the adipose fin marking system, significant information gaps regarding this marking system for the protection of wild fish, adipose fin function and composition, and effects of fin clipping on survival. Literature references were gathered from various libraries, reference services, and personal communications with colleagues. Bibliographies for fin regeneration, effect of fin marking on survival, and hooking mortality and related studies are found in Appendix A, B, and C. respectively.

RESULTS

Mark Operations

The 1984 mark season started at Hagerman National Fish Hatchery 25 September and concluded at Dworshak National Fish Hatchery on 14 December. A total of 36 work days (10,336 man hours) utilizing two trailers and two 8-hour shifts of 16 workers each shift were required to mark the 6,360,542 steelhead trout at Idaho's facilities, Table 1 summarizes the marking operation,,

Quality Check

A sample of 9,947 fish of the total 6,360,542 or 0.16% were checked initially for clip quality. A second quality check was taken at Hagerman National and Dworshak National fish hatcheries in April prior to release, The necessity of limited handling just prior to release

Table 1. Summary of Idaho steelhead adipose fin mark operations, 1984-85.

	Hagerman National Hatchery	Niagara Springs Hatchery^c	Dworshak National Hatchery	Total
No. fish marked	1,421,694	2,502,125	2,436,723	6,360,542
No. of days required	8.5	12.5	15.0	36
Total no. marker hours	1,896	2,971	3,315	8,182
Total no. netter hours	264	564	445	1,273
Total no. supervisory hours ^a	240	336	305	881
Total man hours	2,400	3,871	4,065	10,336
No. fish clipped/marker day ^b	5,999	6,737	5,880	6,219
No. fish/man hour	592	646	599	615
Total mortality	3,025	11,710	1,660	16,395
Percent mortality	0.2	0.5	0.5	0.3

^aIncludes setup and cleanup.

^bMarker day = 8 hrs. (includes 1/2 hr. total break time),

^cAll daily and hourly figures include 8 hrs. of paid holiday time for each employee during this operation. Actual work days were 11.5.

restricted the sample sizes to 207 and 705 fish, respectively. Table 2 summarizes the quality checks.

No descaling was found during the operation. The fish were still small and in a pre-smoltification period when the scales are not deciduous. Prior to release, the fish were again checked. Some scale loss was observed, but was not attributable to the adipose marking operation.

Healing of the Clip

Observations of fish in the raceways at all hatcheries indicated complete healing of the tissue in the area of excision within 3-4 weeks. Fish that had been clipped too deeply usually showed signs of fungus within one week. There were also observed cases of nipping at the excised white area. In severe cases, fish with fungus died and accounted for the largest percentage of the observed delayed mortality. Mortality from this cause ended within four weeks. Observation from the in vivo test at Dworshak National Fish Hatchery indicated healing was rapid and complete within 22 days (Pat Chapman, IDFG, personal communication). From observation and photographs there was no apparent difference in the various full and partial clips in terms of regeneration or healing.

Mortality

Mortality was greatly reduced this year primarily because the marking was done in the fall. For example, mortality of fish marked in the spring at Hagerman National Fish Hatchery last year was 26,000 fish due to the fin clip operation. The fish were extremely large (406/lb) and smolted. This year we marked in the fall and experienced only 3,025 mortalities. The fish were 33-38/lb, and smoltification had not taken place. There was also no indication of descaling. The previous year, descaling was believed to be a large contributor to secondary infection and subsequent high mortality. Table 1 summarizes the mortalities at each hatchery.

Adipose Fin Histological Examination

Histological analysis for both juvenile and adult steelhead trout showed the adipose fins to be composed primarily of fibrous connective tissue interspersed with few blood vessels and occasional adipose (fat) cells. Special connective tissue stain demonstrated a high percentage of collagenous fibers typical of fibrous connective tissue. There was no evidence of glandular or secretory epithelial cells which could be associated with hormonal production. There were no differences in the composition of fins from juvenile and adult steelhead trout (Charlie Smith, personal communication).

Table 2. Summary of adipose fin clip quality checks at Idaho hatcheries, 1984-85.

Hatchery	Total sampled	% excellent ^a	% deep ^b	% poor ^c	% partial ^d	% unclipped ^e
Hagerman National	2,026	84.5	0.2	12.0	1.4	0.7
Niagara Springs	4,320	86.0	2.0	10.0	2.0	0.3
Dworshak National	3,601	94.8	<u>0.0</u>	<u>2.4</u>	<u>2.0</u>	<u>0.7</u>
Mean		88.4	0.7	8.1	1.8	0.6

^aExcellent-100% removal.

^bDeep-100% removal but secondary infection possible.

^cPoor-less than 10% remaining.

^dPartial-10-25% remaining.

^eNot clipped-more than 25% remaining.

DISCUSSION

Ad Mark Operations

In the past two years all steel head trout reared at Idaho hatcheries have received an adipose clip. This year's operations were better timed and less stressful on the fish -than the previous year. The lower mortality reflects the improved conditions better than any single factor. The combined mortality for all three hatcheries was 0.3% of the total fish marked compared to 0.8% in 1984. Handling mortality decreased throughout the operation as supervisory and marking personnel became familiar with equipment and handling practices. We should experience even lower mortalities in subsequent years as personnel gain experience and improve on the present system. At this time, there are no major logistic or biological problems that should hinder the continued marking of Idaho's steelhead trout production,

Clip Quality

Random samples taken during the operations indicated an improvement in quality of the clip as personnel became more proficient. In evaluating the quality of the clip into the five categories, the rating system contains some subjectivity in estimating the percentage of the fin area remaining. If the fish are small in size (>75/lb), a very small amount of unclipped tissue may result in a poor mark. Conversely, a small portion of fin remaining on a large fish may heal into nothing more than a slight bump and result in an acceptable clip.

Those fish determined to be in the unclipped category are a result of two factors. The first is an extremely poor clip where the fin was "topped" or missed entirely. This usually happens when a few small fish are mixed with a majority of larger fish. Secondly, a fish can flip out of the marker's hand and into the return pipe. This is usually because of improper anesthetization. Initial and final percentages indicate this category does not change significantly and remains less than 1% in a quality operation.

Regardless of the classification type and the percentages of the final evaluation, the "quality checks" do serve a critical need during the marking operations. They assure that a mark is being applied that can be recognized by anglers. Any fin missing over 75% of its mass is easily recognized as a clip. The quality checks indicate less than 1% of the adult hatchery steelhead trout returning to Idaho from this outmigration will have adipose fins large enough to be classified as unmarked.

Clip Healing

Healing of the area of excision is dependent on several factors including fish health, water quality and temperature, and size at clipping. Larger fish tend to expose more tissue (white area) and usually suffer higher losses due to nipping, which turns into "sore back". Less "sore back" is observed when fish are clipped at smaller sizes. Chips which are too deep expose even more tissue area and result in severe cases of nipping and "sore Back". Secondary infections such as fungus also result from too deep a clip. In these cases, the fish usually never heals, and death occurs within one month.

Water temperature is critical and can be beneficial or detrimental. As a rule, fish tend to heal faster in warmer water (10 F), but fungus and secondary infections usually increase. Conversely, fish in cold water (1 to 5 C) heal more slowly, but show less signs of fungus and secondary infections. Fish marked in cold water temperatures appear to take the stress of the handling operation better, and fewer mortalities result.

In general, fish heal remarkably fast and from observed and in vivo observations, healing time is not a critical factor in the marking operation. Post-marking prophylactic treatments usually control any complication resulting from the excision of the adipose fin.

Adipose Fin Composition and Purpose

The salmonid adipose fin is relatively small, fleshy, and immobile. It does not contain any skeletal elements, is scaleless, and covered only by the dermis and epidermis. It is filled with an amorphous matrix of loose connective tissue (Harder 1975).

Historically, the adipose fin was thought to be a vestigial fin without purpose and comprised mostly of fatty tissue and, thus, the name--adipose. Weisel (1968) found no fat in sockeye salmon (Oncorhynchus nerka) and only 3-4 drops/section in the cutthroat trout (Salmo clarki) and brown trout (Salmo trutta). In recent years, there have been several hypotheses that the fin may serve other functions ranging from hormonal regulation to pH balance. No literature to substantiate any of these hypotheses could be found. The histological examination found no evidence of glandular or secretory epithelial cells which normally are associated with endocrinal or hormonal functions. Stuart (1958) does make mention that the size and shape of the adipose fin is a secondary sex characteristic in spawning salmonids with the female fin long, thin, and narrow at the base in comparison to a short, thick, wide-based male fin.

Aleyev (1977) suggested the adipose fin in salmonids functioned basically the same as finlets in the Scombridae (mackerel, tuna, etc.), i.e., It functions to transversely streamline the caudal peduncle for faster swimming.

Fin Regeneration

The practice of fin clipping fish for the purpose of identification has been used for many years. There are many advantages and disadvantages of this type of identification procedure. At question in all studies utilizing fin clipping is whether the fin will partially or completely regenerate, thus rendering the mark difficult to recognize at a later date. Several studies have been conducted to evaluate the regeneration of the various types of fins.

Mars (1976) studying brook trout (*Salvelinus fontinalis*) found regeneration had occurred in 9% of all fins observed. The frequency of regeneration was highest (41%) for the anal fin and lowest (9%) for the adipose. Regeneration of the pectoral fins was 1.5 to 2.0 times more frequent than that of pelvic fins. Few fins regenerated to more than 50% of their original size.

Johnson and Shelton (1958) found little regeneration of either adipose or pectoral fins on fall chinook at the Spring Creek Hatchery with 99.2% of all fish with a double fin mark easily identified as double-marked fish four months after marking.

Stauffer and Hansen (1969) utilized left maxillary, right maxillary, adipose, right pectoral, and right pelvic clips to mark rainbow trout. After two years in the hatchery, 95% or more of the pelvic, pectoral, and maxillary clips were recognizable (one-half or less of the fin regenerated). There was no regeneration of the adipose fin.

Shetter (1951) marked four groups of lake trout (*Salvelinus namaycush*) with various fin clips. The adipose clip had 5.2% regeneration, the dorsal 6.4% right pectoral 3.5%, left pectoral 10.2%, and right ventral 35.9% (one-half or more of the fin remaining). However, there appears to be some ambiguity in his reference to the quality of the clipping operation, especially for the right ventral clip.

Hale (1954) found pelvic fin regeneration to be "complete" (both fins similar and normal in size and spread) in 31.5% of the brook trout he held for 14 months 10 days. Most of the remaining fish showed "partial" (one fin club-like in appearance and the other club-like or completely regenerated) or "considerable" (one or both fins somewhat smaller and spreading like a normal fin) fin regeneration (13.7% and 47.5%, respectively). He attributed this high regeneration to inexperience and lack of skill of those clipping small fish (3.0 inches total length).

Other authors have also reported varying results. However, the various studies indicate that the adipose has the least regeneration, with the pelvics next, followed by the pectorals and anal, in respective order. In each study reviewed, a hypothesis was made that a fin with 50% remaining was regenerated. Few studies acknowledged that the regeneration could be aggravated by poor clipping technique. For

many studies, the percentage of regeneration may be nothing more than an indication of initial clip quality. Experience and results of marking juvenile salmon and steelhead for the IDFG coded-wire tagging program has shown that adipose fins properly and totally excised will not regenerate.

Examination of adult steelhead and salmon marked with an adipose clip and coded-wire tag as a juvenile indicates there is no regeneration in a complete clip and only slight regeneration of a partially clipped fin as the incision heals. However, these are usually recognizable as a clip and only when approximately 25% or less of the fin is removed does the mark become questionable. Fish marked with a coded-wire tag and left ventral clip indicate no regeneration of the clip if the fin is clipped below the basal bone. However, leaving only a few fin rays can result in an entire but usually deformed fin. Again, the amount of regeneration is directly related to the quality of the clip. In the case of the ventral clip, a poorly applied clip usually results in the loss of information since it is difficult to differentiate a regenerated fin on a hatchery fish from the deformation the fin may have received during rearing.

Stuart (1957) details pictorially the regeneration of partially clipped fins. The observations made in the coded-wire tagging program are basically in agreement with his study.

Marked Fish Survival

Experimentation utilizing marked fish assumes no differential in survival of marked fish and their unmarked counterparts they represent. However, there are studies reporting differential survival of the various clips. A differential in survival may be a result of interference with swimming ability, endurance, behavior, or growth. Other factors such as handling during marking, physiological condition of the fish at marking, size at marking, and others may also play an important role.

Bonham (1968) concluded that a maxillary mark on chinook salmon (Oncorhynchus tshawytscha) retarded growth and probably induced mortality and was less desirable than a ventral clip. Wales (1947) found the survival of pelvic clipped fingerling brook, brown, and rainbow trout to be better than similar lots of pectoral fin clipped fish. Shetter (1951) tested the survival of lake trout receiving a single pectoral, single pelvic, or dorsal plus adipose fin clip. After correction for fin regeneration, he concluded there was no significant difference between the survival rates of the marked and unmarked fish. Armstrong (1949) found no difference in the survival rates of unmarked and adipose-clipped lake trout fingerlings after 10 months. Experiments conducted by Nelson (1960) indicated that the removal of the pelvic, adipose, or dorsal fins did not significantly affect the survival of fingerling brook or rainbow trout under hatchery conditions. Other authors such as Ricker (1949) and Foerster (1936)

found that marked fish survived significantly less than unmarked fish during their studies. In another experiment, Shetter (1952) found that fin clipped fingerling lake trout (utilizing the same clips as in his previous work) did not suffer any greater losses from predation than did unmarked fish. Horack (1969) using a stamina tunnel tested the swimming ability of 3.3 to 4.0 inch rainbow trout. He found that swimming ability was not significantly affected by removing either the dorsal, both pelvic, both pectoral, anal, or adipose fins. He concluded that the removal of both ventral or pectoral fins may reduce stamina and should be used with caution. A caudal clip severely reduced stamina and could affect the outcome of studies, Nicola and Cordone (1973) studied the long-term survival of fin clipped and unmarked rainbow trout in Castle Lake, California. They found that any fin clip was detrimental. The adipose fin clip reduced survival by as much as 50%. The removal of a ventral fin reduced survival by as much as 60% to 70%. The removal of a pectoral or dorsal fin reduced survival 70% to 80%. The removal of an anal fin was not any worse than the removal of the pectoral or dorsal, but removal had an inconsistent effect. They concluded that the anal fin clip should be avoided unless full excision could be guaranteed.

In the preliminary analysis of the Oregon Coastal Zone Management Association (proposal to mark hatchery-reared coho in the Oregon Production Index (OPI) area in 1984, a special task team evaluated the effects of marking. They concluded that in all experimental cases reviewed, extra handling and stress of fin clipping caused reduced survival. It also appeared that the survival effect went beyond immediate mortality due to stress in the hatchery, Although they could not identify the specific cause, evidence suggested that the removal of the adipose fin causes reduced ocean survival compared to unclipped fish. Loss of other fins or maxillary bones caused even greater losses. From the best available data, they concluded that adipose fin clipping would cause the loss of 5% to 20% of the hatchery coho production compared to unclipped releases. However, the data they present (Table 6, page 23 of the proposal), with the exception of one group, shows the adipose clip in conjunction with another mark. In almost all cases presented, the groups receiving a second mark in addition to the adipose clip survived less than the one group receiving only an adipose clip. The sources they used to estimate the 5% to 20% mortality for an adipose clip are not cited. Evidence from Idaho's fish marking, coded-wire tagging, and freeze branding operations indicates that mortality increases with each additional mark applied to the same fish.

Though there are many studies documenting marked fish survival and the differential survival between marked and unmarked fish, it appears from the literature available that the removal of the adipose fin affects survival of the fish the least followed by the pelvics, pectorals, and dorsal. The caudal, anal, and maxillary are the least desirable to use and studies indicate they may significantly affect survival.

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The bibliographies presented are by no means complete. They are compilations from several research projects, books, and journals. Paul Mongil (1984) and Victor A. Lewynsky (1980) both have done extensive reviews of literature on hooking mortality. Their work, along with others, are included.

ACKNOWLEDGEMENTS

Todd Garlie and Arnie Miller supervised the marking operations. Lance Nelson and Vicki Knieriem assisted in report preparation. Dr. Art Tautz, University of British Columbia, and Robert S. Hooton, Fisheries Management, British Columbia, gave valuable assistance concerning research in Canada. Pat Chapman, Idaho Fish and Game, monitored in vivo tests at Dworshak National Fish Hatchery. Charlie E. Smith, United States Fish and Wildlife Service, Fish Cultural Development Center, did the histological analysis,

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A P P E N D I C E S

Appendix A. BIBLIOGRAPHY - Marked Fish Survival

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Appendix B. BIBLIOGRAPHY - Fin Regeneration

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Appendix C. BIBLIOGRAPHY - Hooking Mortality

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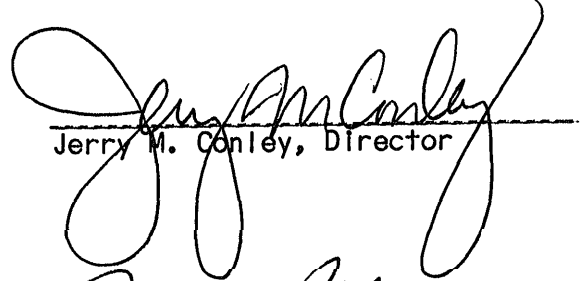
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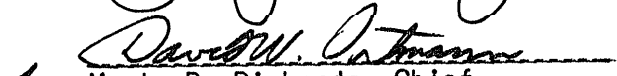
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IDAHO DEPARTMENT OF FISH AND GAME

A large, stylized handwritten signature in black ink, appearing to read "Jerry M. Conley".

Jerry M. Conley, Director

A handwritten signature in black ink, appearing to read "Monte R. Richards".
for Monte R. Richards, Chief
Bureau of FisheriesA handwritten signature in black ink, appearing to read "Steve W. Huffaker".
Steve Huffaker
Anadromous Hatchery Supervisor